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Kaler et al.

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(54) **FLEXIBLE ELECTRONIC MESSAGE SECURITY MECHANISM**

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(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

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(21) Appl. No.: **10/693,290**

(22) Filed: **Oct. 23, 2003**

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Related U.S. Application Data

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(51) **Int. Cl.**

G06F 7/04	(2006.01)
H04L 9/32	(2006.01)
G06F 21/00	(2006.01)

(52) **U.S. Cl.** **726/5**; 713/186; 726/6

(58) **Field of Classification Search** 726/5, 726/6; 713/186

See application file for complete search history.

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(74) *Attorney, Agent, or Firm*—Workman Nydegger

(57) **ABSTRACT**

Multiple different credentials and/or signatures based on different credentials may be included in a header portion of a single electronic message. Different recipients of intermediary computing systems may use the different credentials/signatures to identify the signer. The electronic message may include an encoding algorithm and a type identification of a credential included in the electronic message, allowing the recipient to decode and process the credential as appropriate given the type of credential. Also, the electronic message may include a pointer that references a credential associated with a signature included in the electronic message. That referenced credential may be accessed from the same electronic message, or from some other location. The recipient may then compare the references credential from the credentials used to generate the signature. If a match occurs, the integrity of the electronic message has more likely been preserved.

53 Claims, 6 Drawing Sheets

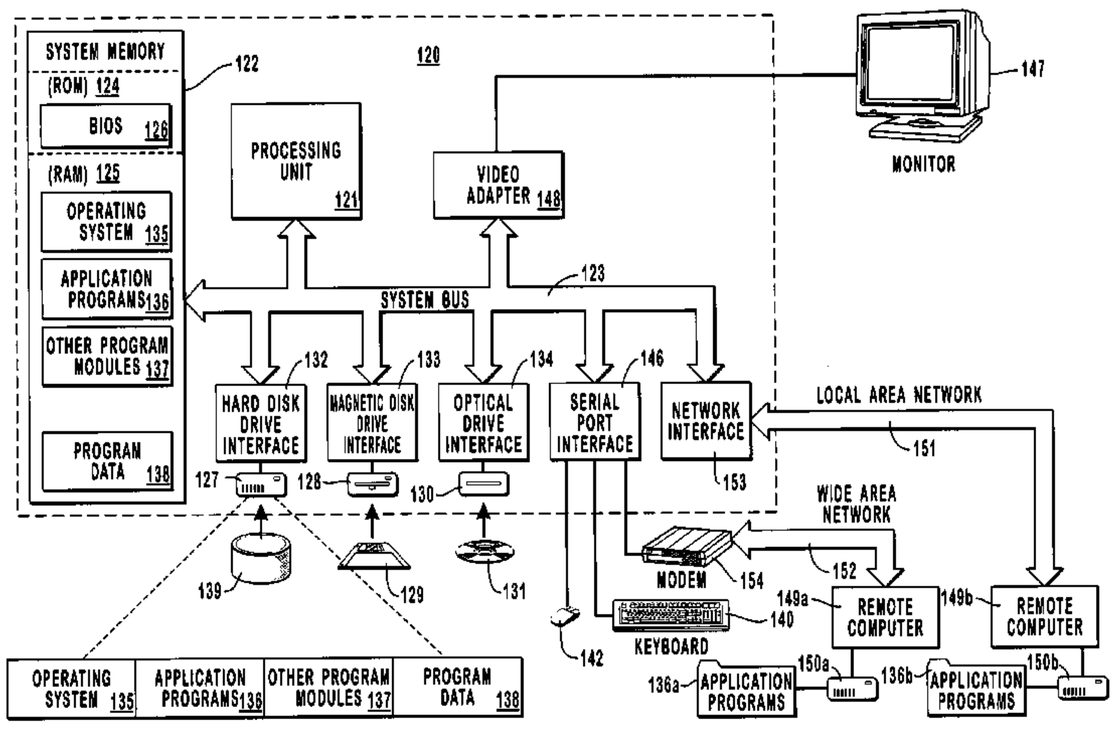

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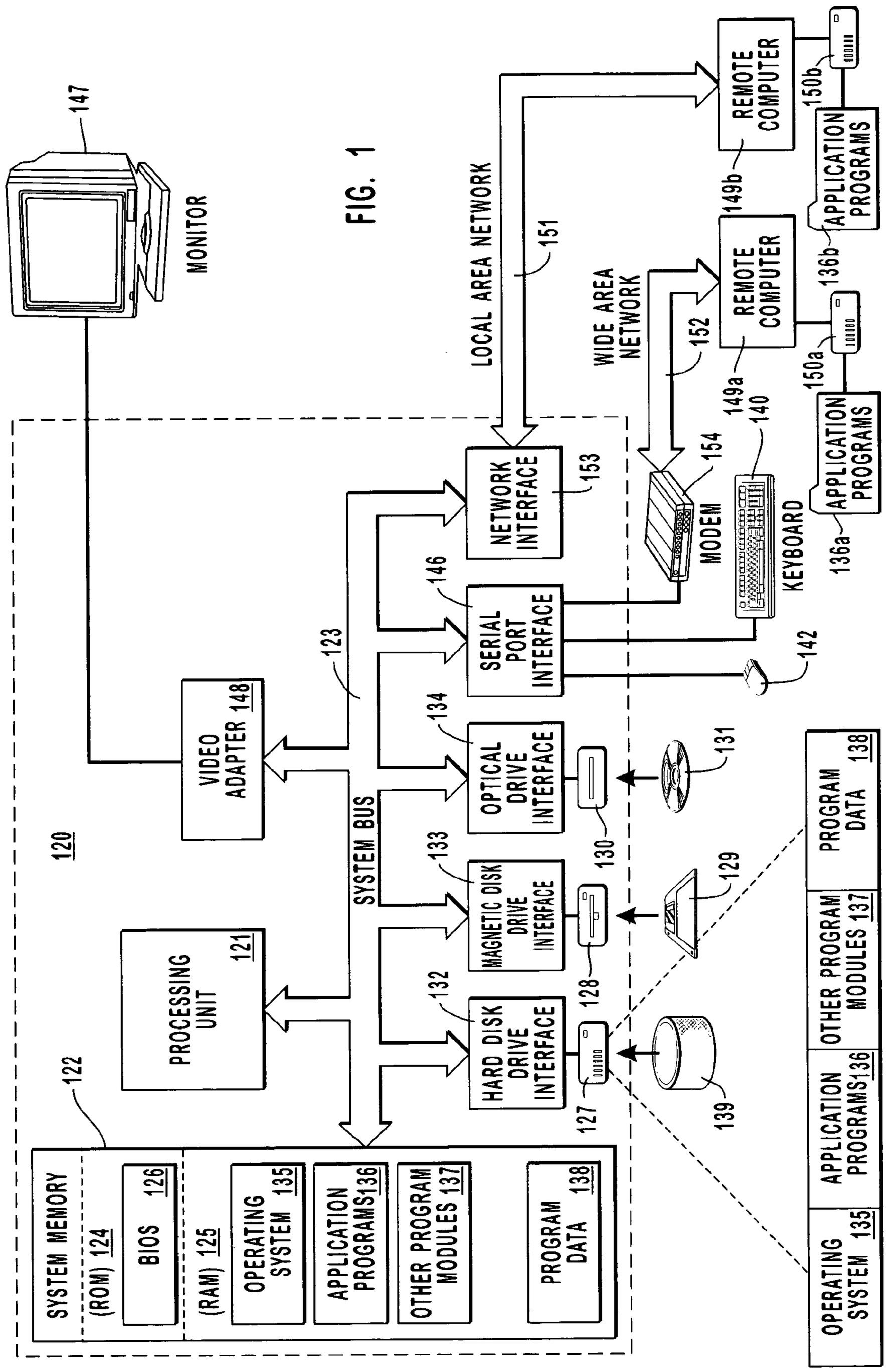
FIG. 1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MONITOR
LOCAL AREA NETWORK
151
WIDE AREA NETWORK
152
REMOTE COMPUTER
149b
150b
APPLICATION PROGRAMS
136b
REMOTE COMPUTER
149a
150a
APPLICATION PROGRAMS
136a
140
KEYBOARD
154
MODEM
NETWORK INTERFACE
153
146
SERIAL PORT INTERFACE
142
123
VIDEO ADAPTER 148
134
OPTICAL DRIVE INTERFACE
131
130
133
MAGNETIC DISK DRIVE INTERFACE
129
132
HARD DISK DRIVE INTERFACE
128
127
139
120
PROCESSING UNIT 121
SYSTEM BUS
122
SYSTEM MEMORY
(ROM) 124
BIOS 126
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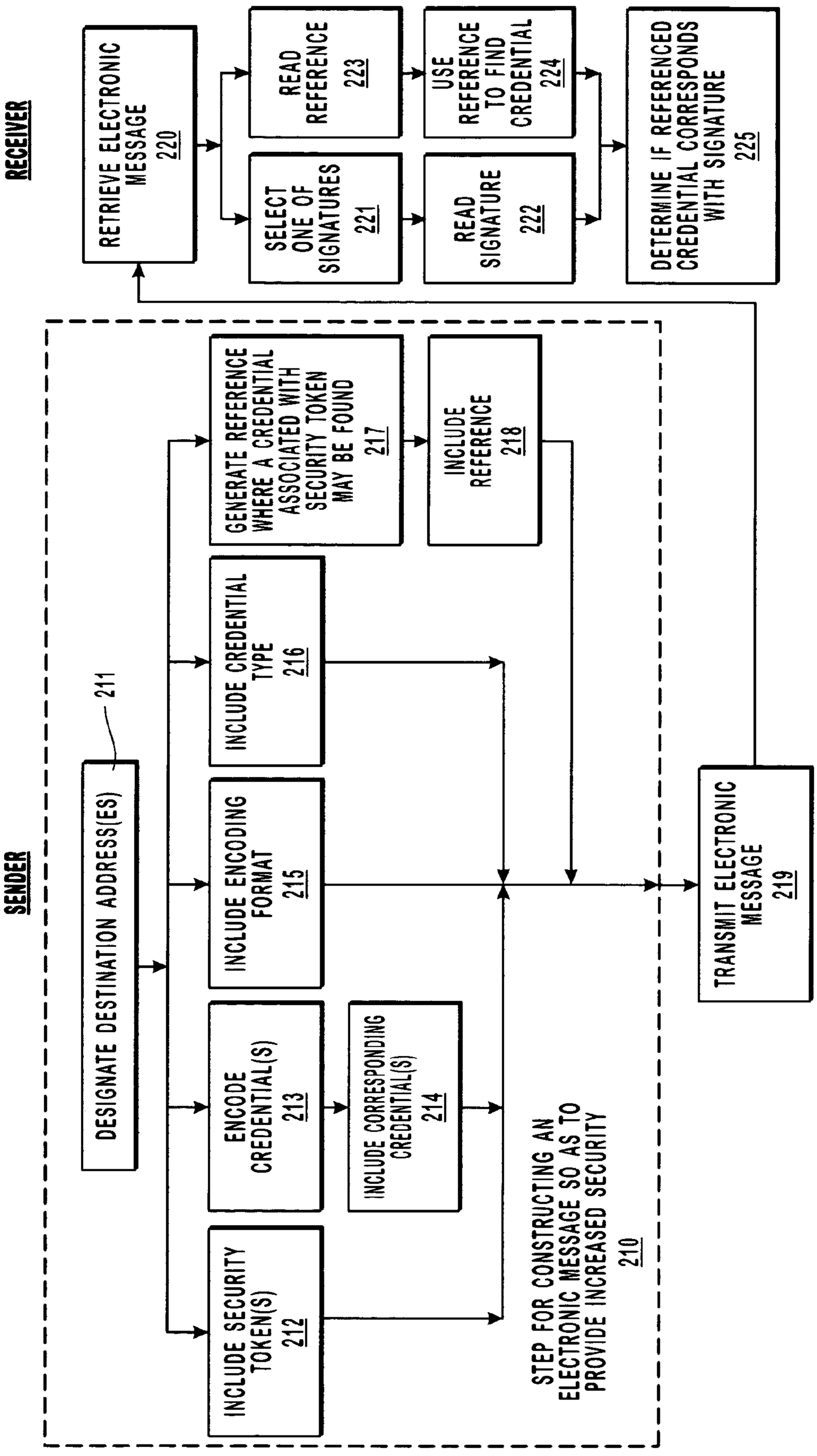
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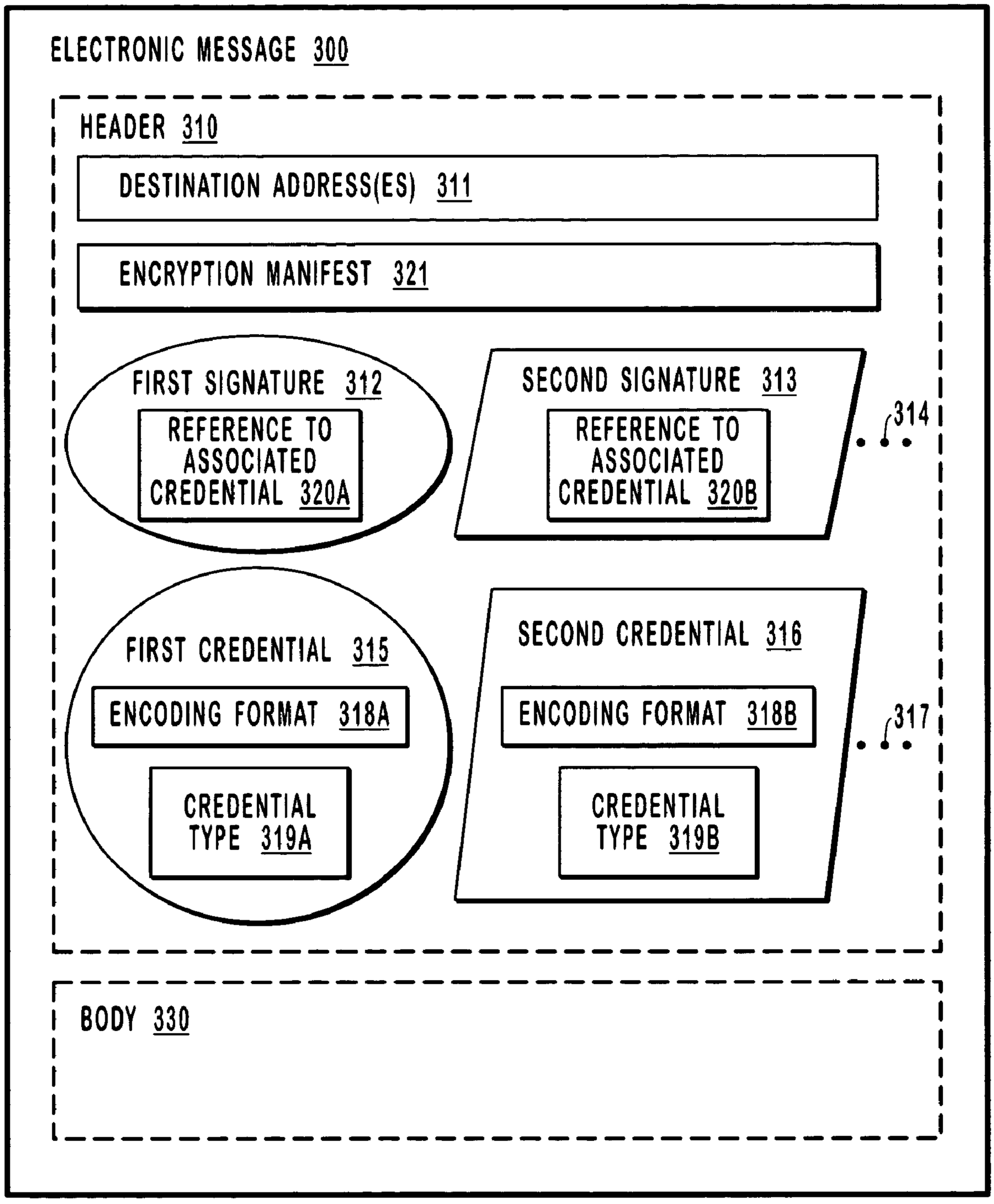
RETRIEVE ELECTRONIC MESSAGE 220
READ REFERENCE 223
USE REFERENCE TO FIND CREDENTIAL 224
SELECT ONE OF SIGNATURES 221
READ SIGNATURE 222
DETERMINE IF REFERENCED CREDENTIAL CORRESPONDS WITH SIGNATURE 225
SENDER
211
DESIGNATE DESTINATION ADDRESS(ES)
GENERATE REFERENCE WHERE A CREDENTIAL ASSOCIATED WITH SECURITY TOKEN MAY BE FOUND 217
INCLUDE REFERENCE 218
INCLUDE CREDENTIAL TYPE 216
INCLUDE ENCODING FORMAT 215
ENCODE CREDENTIAL(S) 213
INCLUDE CORRESPONDING CREDENTIAL(S) 214
INCLUDE SECURITY TOKEN(S) 212
TRANSMIT ELECTRONIC MESSAGE 219
STEP FOR CONSTRUCTING AN ELECTRONIC MESSAGE SO AS TO PROVIDE INCREASED SECURITY 210

FIG. 2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REFERENCE TO ASSOCIATED CREDENTIAL 320A
SECOND SIGNATURE 313
REFERENCE TO ASSOCIATED CREDENTIAL 320B
314
FIRST CREDENTIAL 315
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CREDENTIAL TYPE 319A
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CREDENTIAL TYPE 319B
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BODY 330

FIG. 3

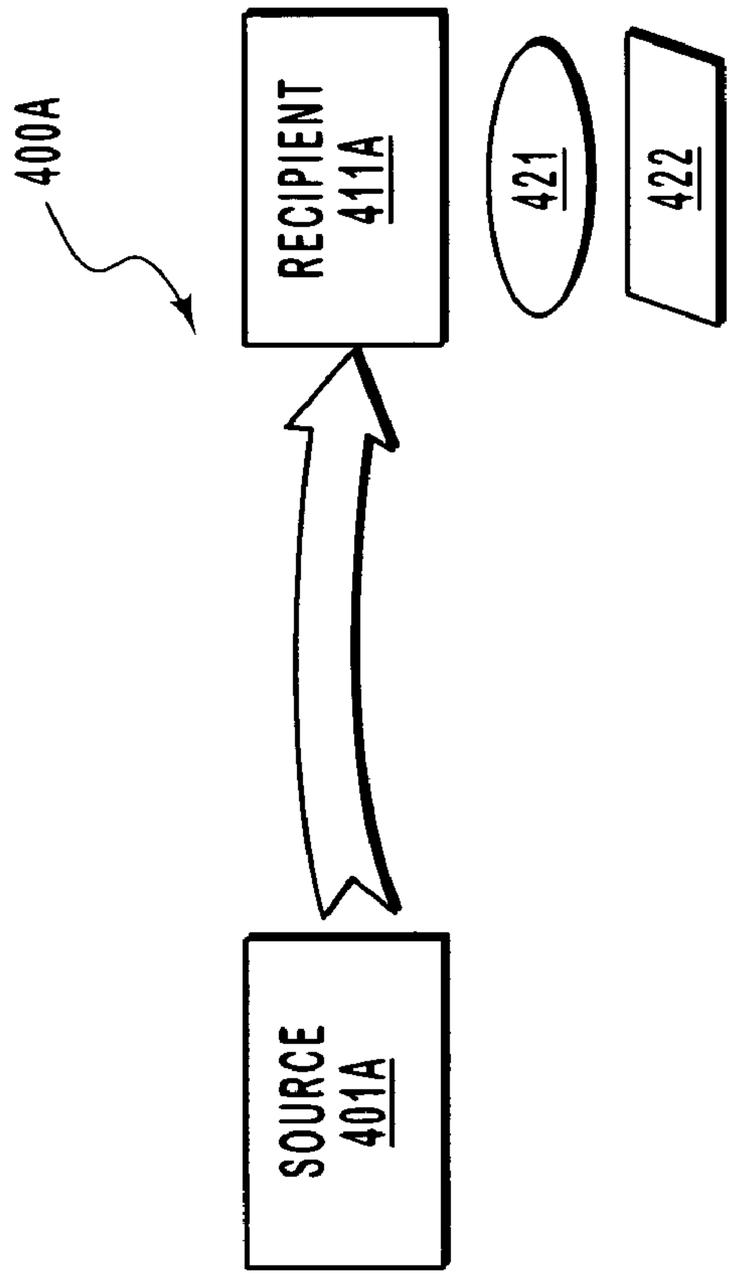
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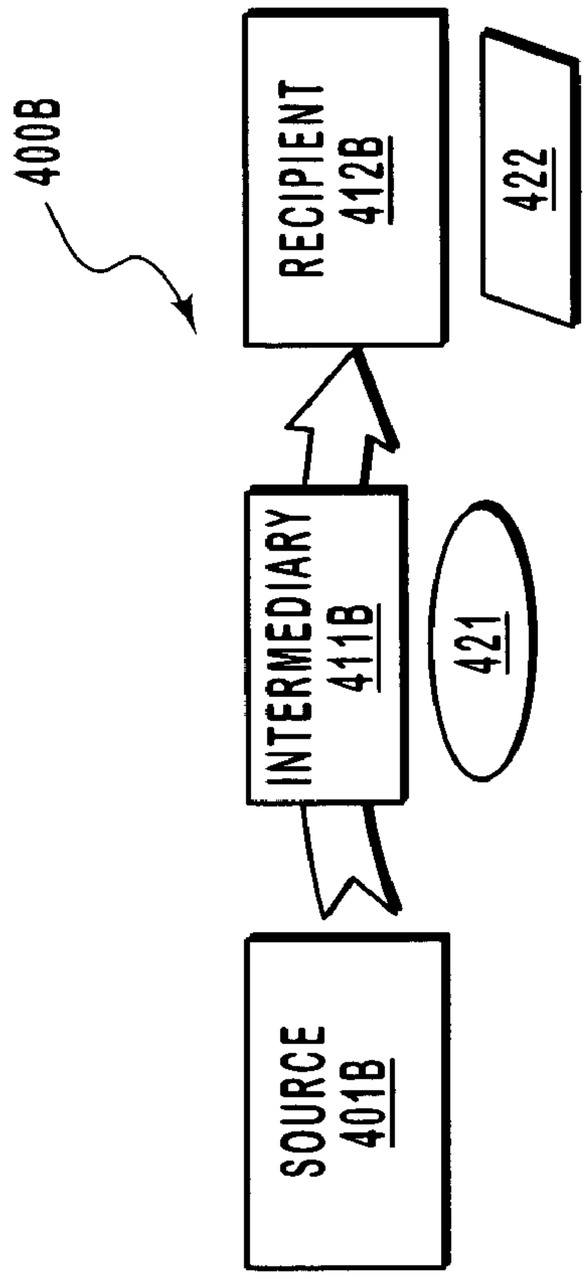
FIG. 4A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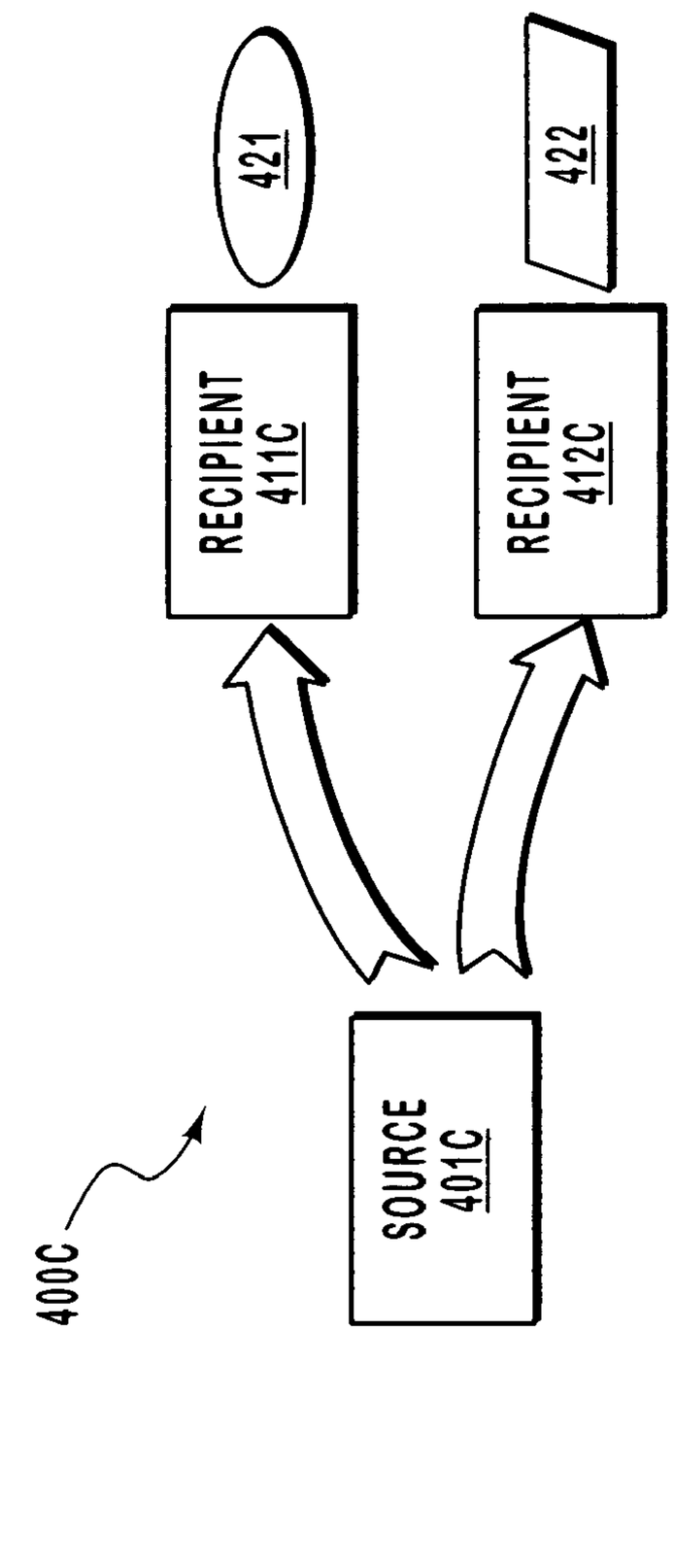
400C
SOURCE 401C
RECIPIENT 411C
RECIPIENT 412C
421
422

FIG. 4C

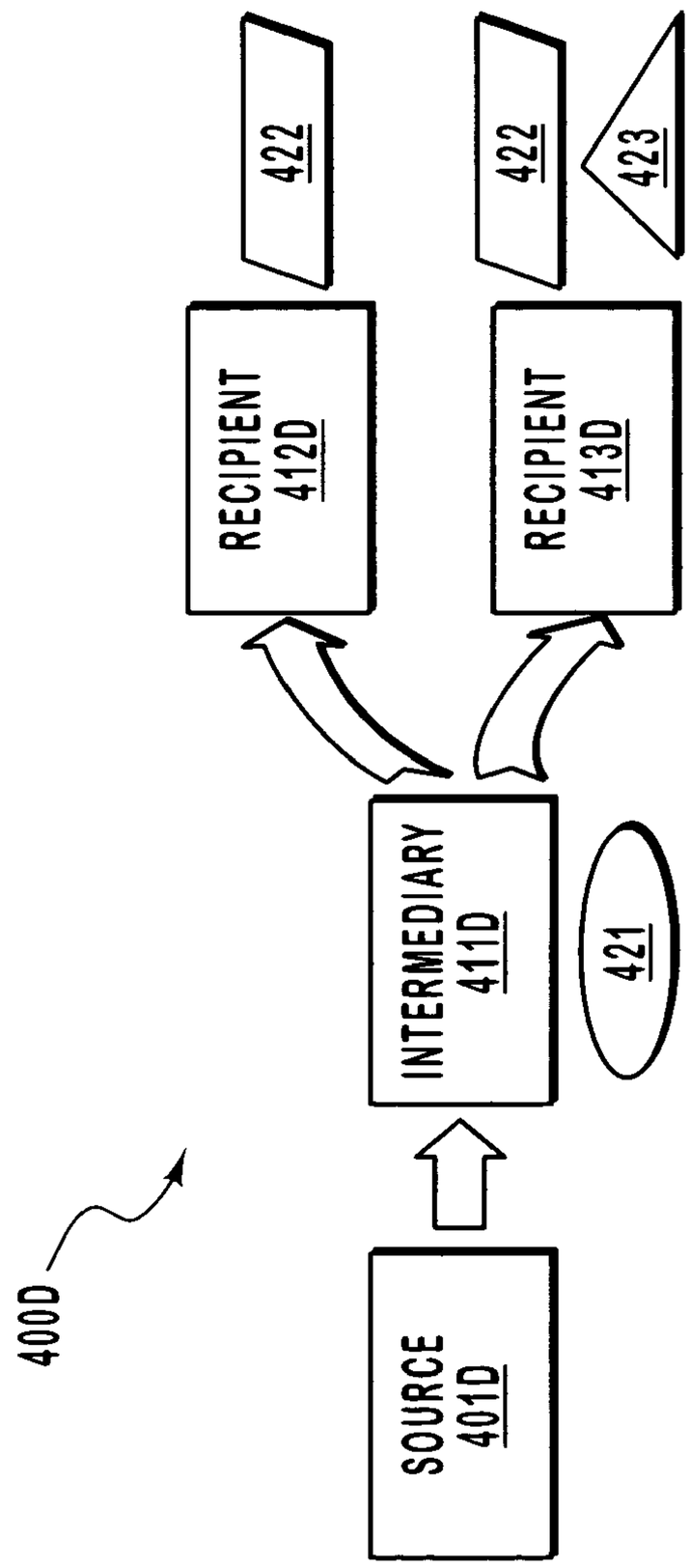
400D
SOURCE 401D
INTERMEDIARY 411D
RECIPIENT 412D
RECIPIENT 413D
421
422
423

FIG. 4D

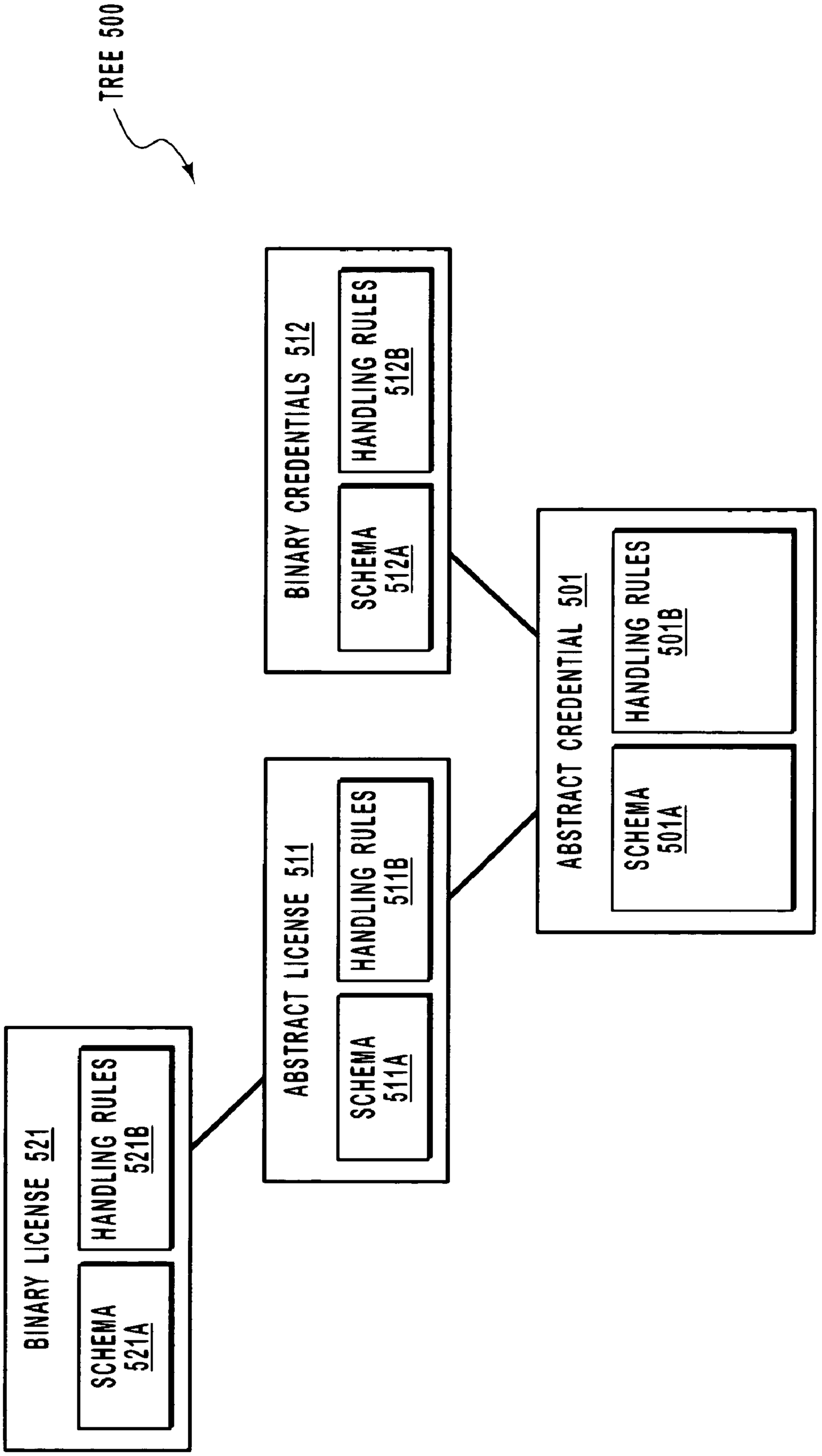
TREE 500
BINARY CREDENTIAL 512
SCHEMA 512A
HANDLING RULES 512B
ABSTRACT CREDENTIAL 501
SCHEMA 501A
HANDLING RULES 501B
BINARY LICENSE 511
SCHEMA 511A
HANDLING RULES 511B
ABSTRACT LICENSE 521
SCHEMA 521A
HANDLING RULES 521B

FIG. 5

FLEXIBLE ELECTRONIC MESSAGE SECURITY MECHANISM

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a continuation-in-part application of commonly-assigned U.S. patent application Ser. No. 10/219,898 filed Aug. 14, 2002 now U.S. Pat. No. 7,293,283 and entitled "Flexible Electronic Message Security Mechanism." That patent application claims priority to U.S. provisional patent application Ser. No. 60/329,796 entitled "System and Method for Security, Licensing and Naming" filed Oct. 16, 2001, and claims priority to U.S. provisional patent application Ser. No. 60/346,370 also entitled "System and Method for Security, Licensing and Naming" filed Oct. 19, 2001.

BACKGROUND OF THE INVENTION

1. The Field of the Invention

The present invention relates to electronic messaging, and more particularly, to mechanisms for allowing more flexible use of security mechanisms when communicating using electronic messages.

2. Related Technology

Computing technology has transformed the way we work and play. Modem computer networking technologies and infrastructures allow for different applications and users to communicate data electronically even over vast distances relatively quickly using readily-available computing systems. Such computing systems may include, for example, desktop computers, laptop computers, Personal Digital Assistants (PDAs), digital telephones, or the like.

Currently, computing systems are so interconnected that one computing system is literally capable of communicating with any one of many millions of other computing systems spread throughout the globe. This is useful as we are now able to communicate more readily. However, this high level of interconnectivity also exposes us to security problems. For example, often it is necessary to verify that a computing device or associated user is truly the same entity that they purport to be in a process called authentication. Also, it is often important to validate the integrity of an electronic message to be sure that the electronic message has not been compromised during transmission.

Improvements in security mechanisms are of significant benefit since breaches in security can cause much harm, financial and otherwise, to entities who rightfully desire secure electronic communications. The principles of the present invention improve security over conventional security technologies as will be described in further detail below.

BRIEF SUMMARY OF THE INVENTION

The principles of the present invention relate to mechanisms for providing reliable and flexible security mechanisms when communicating using electronic messages. The electronic message may have multiple different types of credentials. The electronic message may include the encoding format and type of each of the credentials thus allowing for convenient access of the credential by either the recipient computing system, or by an intermediary computing system. The electronic message may also include multiple signatures that were each signed using a different credential. The signatures may each have a reference to a location even external to the electronic message. The recipient computing system may

evaluate the external credential against the signature to determine whether tampering of the electronic message may have occurred.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by the practice of the invention. The features and advantages of the invention may be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims. These and other features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

FIG. **1** illustrates a suitable computing system in which the principles of the present invention may be employed;

FIG. **2** illustrates a flowchart of a method for securely transmitting an electronic message in accordance with the principles of the present invention;

FIG. **3** illustrates a data structure of an electronic message having multiple different types of credentials in the header of the electronic message in accordance with the principles of the present invention;

FIG. **4**A illustrates a network environment in which multiple different credentials are used to identify a source computing system to a particular recipient computing system in a model called herein the "multiple credential—single recipient model";

FIG. **4**B illustrates a network environment in which different credentials in the electronic message may be used to identify the source computing system to an intermediary computing system and to identify the source computing device to a recipient computing system in a model called herein the "serial credential model";

FIG. **4**C illustrates a network environment in which different credentials in the electronic message may be used to identify the source computing system to different recipient computing systems in a model called herein the "parallel credential model";

FIG. **4**D illustrates a network environment which combines all of the models of FIGS. **4**A, **4**B and **4**C; and

FIG. **5** illustrates a credential semantic inheritance tree in accordance with the principles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The principles of the present invention relate to methods, systems, computer program products, and data structures that allow more secure communications of an electronic message.

Multiple different credentials and/or signatures based on different credentials may be included in a header portion of a single electronic message. These different signatures and/or credentials may be used by different recipient computing

systems, by a single recipient computing system, or even by different computing systems along a routing path of the electronic message.

The electronic message may include an identification of an encoding algorithm and the type of credential included in the electronic message. Accordingly, multiple different credentials may be included that have different encoding. The recipient computing system may decode and process the credential as appropriate given the identification of the encoding algorithm and the type of credential.

Also, the electronic message may include a pointer that references a credential that is accessible to the recipient computing system, either within the same electronic message, or from some other location. The recipient computing system may then compare the referenced credentials from the credentials used to generate the signature. If a match occurs, then the data signed can be associated with the credentials. Accordingly, the integrity of any statement made in the credentials such as identity, rights, and so forth, may be verified.

Embodiments within the scope of the present invention include computer-readable media for carrying or having computer-executable instructions or data structures stored thereon. Such computer-readable media can be any available media which can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, such computer-readable media can comprise physical computer-readable media such as RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code means in the form of computer-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer. The computer-readable media may include at least partially run-time memory that holds data structures and modules that exist at run-time. The computer-readable media may also include persistent memory that stores data structures that persist regardless of the existence and/or reliability of externally supplied power.

When information is transferred or provided over a network or another communications connection (either hardwired, wireless, or a combination of hardwired or wireless) to a computer, the computer properly views the connection as a computer-readable medium. Thus, any such a connection is properly termed a computer-readable medium. Combinations of the above should also be included within the scope of computer-readable media. Computer-executable instructions comprise, for example, instructions and data which cause a general purpose computer, special purpose computer, or special purpose processing device to perform a certain function or group of functions.

FIG. **1** and the following discussion are intended to provide a brief, general description of a suitable computing environment in which the invention may be implemented. Although not required, the invention will be described in the general context of computer-executable instructions, such as program modules, being executed by computers in network environments. Generally, program modules include routines, programs, objects, components, data structures, and the like, that perform particular tasks or implement particular abstract data types.

Those skilled in the art will appreciate that the invention may be practiced in network computing environments with many types of computer system configurations, including personal computers, hand-held devices, multi-processor systems, microprocessor-based or programmable consumer electronics, network PCs, minicomputers, mainframe computers, and the like. The invention may also be practiced in distributed computing environments where tasks are performed by local and remote processing devices that are linked (either by hardwired links, wireless links, or by a combination of hardwired or wireless links) through a communications network. In a distributed computing environment, program modules may be located in both local and remote memory storage devices.

With reference to FIG. **1**, an exemplary system for implementing the invention includes a general purpose computing device in the form of a conventional computer **120**, including a processing unit **121**, a system memory **122**, and a system bus **123** that couples various system components including the system memory **122** to the processing unit **121**. Throughout this description, element numbers begin with the same number as the figure in which the corresponding elements were first introduced. For example, all of the element numbers in FIG. **1** are numbered in the 100's while the element numbers in FIG. **2** are number in the 200's, and so forth.

The system bus **123** may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. The system memory includes read only memory (ROM) **124** and random access memory (RAM) **125**. A basic input/output system (BIOS) **126**, containing the basic routines that help transfer information between elements within the computer **120**, such as during start-up, may be stored in ROM **124**.

The computer **120** may also include a magnetic hard disk drive **127** for reading from and writing to a magnetic hard disk **139**, a magnetic disk drive **128** for reading from or writing to a removable magnetic disk **129**, and an optical disk drive **130** for reading from or writing to removable optical disk **131** such as a CD-ROM or other optical media. The magnetic hard disk drive **127**, magnetic disk drive **128**, and optical disk drive **130** are connected to the system bus **123** by a hard disk drive interface **132**, a magnetic disk drive-interface **133**, and an optical drive interface **134**, respectively. The drives and their associated computer-readable media provide nonvolatile storage of computer-executable instructions, data structures, program modules and other data for the computer **120**. Although the exemplary environment described herein employs a magnetic hard disk **139**, a removable magnetic disk **129** and a removable optical disk **131**, other types of computer readable media for storing data can be used, including magnetic cassettes, flash memory cards, digital video disks, Bernoulli cartridges, RAMs, ROMs, and the like.

Program code means comprising one or more program modules may be stored on the hard disk **139**, magnetic disk **129**, optical disk **131**, ROM **124** or RAM **125**, including an operating system **135**, one or more application programs **136**, other program modules **137**, and program data **138**. A user may enter commands and information into the computer **120** through keyboard **140**, pointing device **142**, or other input devices (not shown), such as a microphone, joy stick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit **121** through a serial port interface **146** coupled to system bus **123**. Alternatively, the input devices may be connected by other interfaces, such as a parallel port, a game port or a universal serial bus (USB). A monitor **147** or another display device is also connected to system bus **123** via an interface, such as video adapter **148**. In addition to the monitor, personal computers typically include other peripheral output devices (not shown), such as speakers and printers.

The computer **120** may operate in a networked environment using logical connections to one or more remote computers, such as remote computers **149***a* and **149***b*. Remote

computers **149***a* and **149***b* may each be another personal computer, a server, a router, a network PC, a peer device or other common network node, and typically include many or all of the elements described above relative to the computer **120**, although only memory storage devices **150***a* and **150***b* and their associated application programs **136***a* and **136***b* have been illustrated in FIG. **1**. The logical connections depicted in FIG. **1** include a local area network (LAN) **151** and a wide area network (WAN) **152** that are presented here by way of example and not limitation. Such networking environments are commonplace in office-wide or enterprise-wide computer networks, intranets and the Internet.

When used in a LAN networking environment, the computer **120** is connected to the local network **151** through a network interface or adapter **153**. When used in a WAN networking environment, the computer **120** may include a modem **154**, a wireless link, or other means for establishing communications over the wide area network **152**, such as the Internet. The modem **154**, which may be internal or external, is connected to the system bus **123** via the serial port interface **146**. In a networked environment, program modules depicted relative to the computer **120**, or portions thereof, may be stored in the remote memory storage device. It will be appreciated that the network connections shown are exemplary and other means of establishing communications over wide area network **152** may be used.

While FIG. **1** illustrates an example of a computing system that may implement the principles of the present invention, any computing system may implement the features of the present invention. In the description and in the claims, a "computing system" is defined as any hardware component or components that are capable of using software to perform one or more functions. Examples of computing systems include desktop computers, laptop computers, Personal Digital Assistants (PDAs), telephones, or any other system or device that has processing capability.

FIG. **2** illustrates a method **200** for performing electronic messaging in a secure manner. Some of the acts and the step of the method **200** are performed by a sender computing system that sends an electronic message. Those acts and that step are generally listed in the left column of FIG. **2** under the heading "SENDER". Other acts of the method **200** that are performed may be a receiver computing system that receives the electronic message. Those acts are generally listed in the right column of FIG. **2** under the heading "RECEIVER".

The method **200** includes a functional, result-oriented step for constructing an electronic message so as to provide increased security (step **210**). This functional, result-oriented step may include any corresponding acts for accomplishing this result. However, in the illustrated embodiment, the step **210** includes corresponding acts **211** through **218**. An example electronic message data structure is illustrated in FIG. **3** as electronic message **300**. The method of FIG. **2** will be described with frequent reference to the electronic message data structure of FIG. **3**.

The method **200** includes an act of designating at least one destination address in the electronic message (act **211**). The destination address corresponds to one or more recipient computing systems. Referring to FIG. **3**, the electronic message includes a header field **310** and a body field **330**. The body field **330** may contain the content of the information desired to be communicated to the recipient(s), while the header field **310** contains information that facilitates proper and secure transport and processing of the electronic message. The header field **310** includes a destination address field **311** that contains the destination address or addresses of one or more desired recipients of the electronic message.

The header field **310** also includes an encryption manifest **321** (e.g., an XML encryption manifest) that identifies portions of the body field **330** that are encrypted. Accordingly, none, some, or all portions of the body field **330** may be encrypted. The opportunity to encrypt only selected portions of the body field **330** is advantageous as this allows for the more sensitive data in the body field **330** to be encrypted without expending unneeded processor cycles encrypting the less sensitive data in the body field **330** to thereby provide a suitable balance between processing efficiency and security.

The method **300** then includes an act of including one or more security tokens in a header portion of the electronic message (act **212**). The one of more security tokens may be, for example, one or more signatures. For example, the header field **310** includes a first signature **312**, a possible second signature **313**, and potentially other signatures **314**. The first signature **312** is oval-shaped to represent that the first signature may have been signed using a corresponding credential **315**, which is also represented as being oval-shaped. The second signature **313** is trapezoidal-shaped to represent that the second signature may have been signed using a different corresponding credential **316**, which is also represented as being trapezoidal-shaped.

In addition to including the signatures (act **212**) or other security tokens in the electronic message, the method **300** includes an act of encoding one of more credentials (act **213**), and then the act of including the one or more encoded credentials in the electronic message (act **214**). In some cases, the credential(s) included in the electronic message may not be encoded at all thus eliminating act **213**. In other cases, a credential will not be included in the electronic message either thus eliminating act **214**. For example, there may not be any cause for including a credential if there is a reference to an associated credential field described below where the credential may be external to the electronic message.

The credentials may be, for example, any item of information that helps to identify and/or authenticate the credential provider. One type of credential is a license, which contains a set of related assertions signed by an authority. Some assertions may be about keys that may be used to sign and/or encrypt messages. Example licenses include X.509 certificates and Kerberos tickets. The owner of a license is a principle entity that can use the license authoritatively. Specifically, the principle has the knowledge necessary to apply the cryptographic keys located in the attached license or licenses attached therein. Another type of credential is biometric data about the user sending the electronic message. Such biometric data may include any information derived from the biology of the user such as retinal scan data, fingerprint data, DNA data, or any other data that may substantially uniquely identify a user based on the user's biology. In FIG. **3**, the included credentials are represented by first credential **315**, second credential **316**, and other credentials **317**.

The method **200** also includes an act of including, in the header portion, an identification of an encoding format of the credential(s) (act **215**). This identification is represented in FIG. **3** for the first credential **315** by the encoding format field **318**A. The identification is represented in FIG. **3** for the second credential **316** by the encoding format field **318**B. Alternatively, the encoding format is not identified in the header portion thereby indicating that a default encoding format was used to encode the credential. The method **300** also includes an act of including, in the header portion, an identification of a type of the credential (act **216**). For example, the type of credential may be an X.509 certificate or a Kerberos ticket. The identification of the type of credential is represented in FIG. **3** for the first credential **315** by the

credential type field **319**A, and for the second credential **316** by the credential type field **319**B. This type of credential may be a human-readable expression or may just be any information from which the type of credential may be derived.

In this example, there is an identification of the encoding format and a credential type for each of the credentials included in the electronic message, although this is not necessary. For example, in cases in which the encoding format is the same for all of the credentials in the electronic message, the encoding format may be listed in just one portion of the electronic message. Similarly, if the credential type is the same for all of the credentials in the electronic message, the credential format may just be listed once. In addition, if a particular credential has a default encoding format (and/or credential type), then the particular encoding format (and/or credential type) need not be expressly included for that credential. Furthermore, in schema-based communication in which the schema is understood to both parties, the encoding type and/or the credential format may be implicit based on the position of the credential within the schema-based document.

Also, the identification of the encoding format and credential type are illustrated as being included in the corresponding credential field. If these fields are included in the corresponding credential field, acts **215** and **216** would occur concurrently with act **213** for that credential. However, the encoding format and type field may instead just be associated with the corresponding credential field.

The method **300** also includes an act of generating a reference indicating where a credential associated with the signature may be found (act **217**), and including the reference in the header portion of the electronic message (act **218**). The reference is represented in FIG. **3** for the first signature **312** by the reference to associated credential field **320**A, and for the second signature **313** by the reference to associated credential field **320**B. While the reference may include a reference to a position internal to the electronic message (e.g., credential fields **315** and **316**), the reference may also be a Uniform Resource Locator (URL) that identifies a location external to the electronic message where the associated credential may be found.

The sending computing system then transmits the electronic message to one or more recipient computing systems (act **219**), which then receive the electronic message (act **220**). The electronic message may contain multiple different signatures that were generated using multiple different kinds of credentials. The recipient computing system may then select one of a multiple signatures included in a header portion of the electronic message (act **221**), and then read that electronic signature from the electronic message (act **222**). Accordingly, the recipient computing system may choose one, some, or all of the included signatures depending on which one the recipient computing system is configured to process and trust.

The ability of the electronic message **300** to contain multiple credentials of different types allows for several novel network security configurations. For example, FIG. **4**A illustrates a network environment **400**A in which multiple different credentials are used to identify a source computing system **401**A to a particular recipient computing system **411**A in a model called herein the "multiple credential—single recipient model". In this model, a single recipient computing system **411**A uses two different credentials **421** and **422** in order to authenticate the source computing system **401**A. The credentials are illustrated in FIGS. **4**A through **4**D as having different shapes to emphasize that the credentials may be of different types.

FIG. **4**B illustrates a network environment **400**B in which different credentials in the electronic message may be used to identify a source computing system **401**B to an intermediary computing system **411**B and to identify the source computing device **401**B to a recipient computing system **412**B in a model called herein the "serial credential model". In the illustrated serial credential model **400**B, the intermediary computing system **411**B uses the credential **421**, while the recipient computing system **412**B uses the credential **422**.

FIG. **4**C illustrates a network environment **400**C in which different credentials in the electronic message may be used to identify the source computing system **401**C to different recipient computing devices **411**C and **412**C in a model called herein the "parallel credential model". In the illustrated parallel credential model **400**C, the recipient computing system **411**C uses the credential **421**, while the recipient computing system **412**C uses the credential **422**.

There are various combinations of each of the models of FIG. **4**A through **4**C that make a practically limitless variety of network configurations. For example, FIG. **4**D illustrates a network environment **400**D which combines all of the models of FIGS. **4**A, **4**B and **4**C in one of many possible ways. In the environment **400**D, the electronic message includes three credentials **421**, **422** and **423**. Credential **423** is different than credentials **421** and **422** as represented by its triangular shape. The intermediary computing system **411**C uses credential **421**, recipient computing system **412**D uses credential **422**, and recipient computing system **413**D uses credentials **422** and **423**.

Returning to FIG. **2**, the receiving computing system also may read the reference that indicates where an associated credential may be found (act **223**), use that reference to find the credential (act **224**), and then determine if the credential corresponds with the electronic signature (act **225**). If the referenced credential corresponds to the signature, then the data signed can be associated with the credential. Accordingly, the integrity of any statements made in the credentials such as identity, rights, and so forth, may be more assured, especially if the referenced credential was external to the electronic message and thus not subject to the same tampering instances that the electronic message may be subject to.

In one embodiment, the electronic message **300** may be a Simple Object Access Protocol (SOAP) envelope although this is not required. The two provisional patent applications previously incorporated herein by reference provide several examples of SOAP envelopes which incorporate various aspects of the present invention. The following SOAP envelope is a code example of one specific embodiment of the data structure of the electronic message **300**. The code example is represented in eXtensible Markup Language (XML) version 1.0. Line numbering has been added for clarity in explaining the structure of the code example. Although this code example shows one specific implementation, there are a vast variety of different implementations that may employ the principles of the present invention. For example, although this example illustrates the use of headers hierarchically structured in a certain way and having particular header uses, other embodiments may have a different hierarchy and usage of headers without departing from the scope of the principles of the present invention.

```
<?xml version="1.0" encoding="utf-8"?>
<S:Envelope
        xmlns:S="http://schemas.xmlsoap.org/soap/envelope/"
        xmlns:xsd="http://www.w3.org/2001/XMLSchema"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <Header>
      <m:path xmlns:m="http://schemas.xmlsoap.org/rp">
        PATH INFORMATION
    </m:path>
    <wssec:credentials
      xmlns:wssec="http://schemas.xmlsoap.org/ws/2001/10/security">
      <wslic:binaryLicence
        xmlns:wslic="http://schemas.xmlsoap.org/ws/2001/10/licenses"
          wslic:valueType="wslic:x509v3"
          xsi:type="xsd:base64Binary"
          id="X509License">
            X509LICENSE ENCODED IN BASE64BINARY
      </wslic:binaryLicense>
      <wslic:binaryCredential xmlns:tru=". . . ">
        wslic:valueType="tru:binaryCredentialFormat"
        xsi:type="xsd:base64Binary"
        id="BinaryCredential">
          BINARY CREDENTIAL ENCODED IN BASE64BINARY
      </wslic:binaryCredential>
    </wssec:credentials>
    <wssec:integrity>
      <ds:Signature xmlns:ds="http://www.w3.org/2000/09/xmldsig#">
        <ds:SignedInfo>
          <ds:CanonicalizationMethod
            Algorithm="http://www.w3.org/Signature/Drafts/xml-exc-c14n"/>
          <ds:SignatureMethod
            Algorithm"http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
          <ds:Reference>
            <ds:Transforms>
              <ds:Transform Algorithm="http://schemas.xmlsoap.org/
                2001/10/security#RoutingSignatureTransform"/>
              <ds:Transform Algorithm="http://www.w3.org/
                TR/2001/REC-xml-c14n-20010315/>
            </ds:Transforms>
            <ds:DigestMethod Algorithm="http://www.w3.org/
              2000/09/xmldsig#sha1"/>
          </ds:Reference>
        </ds:SignedInfo>
        <ds:SignatureValue>
          FIRST SIGNATURE VALUE
        </ds:SignatureValue>
        <ds:KeyInfo>
          <wssec:LicenseLocation="#X509License"/>
        </ds:KeyInfo>
      </ds:Signature>
      <ds:Signature>
        <ds:SignedInfo>
          <ds:CanonicalizationMethod
            Algorithm="http://www.w3.org/Signature/Drafts/xml-exc-c14n"/>
          <ds:SignatureMethod
            Algorithm"http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
          <ds:Reference>
            <ds:Transforms>
              <ds:Transform Algorithm="http://schemas.xmlsoap.org/
                2001/10/security#RoutingSignatureTransform"/>
              <ds:Transform Algorithm="http://www.w3.org/
                TR/2001/REC-xml-c14n-20010315/>
            </ds:Transforms>
            <ds:DigestMethod Algorithm="http://www.w3.org/
              2000/09/xmldsig#sha1"/>
          </ds:Reference>
        </ds:SignedInfo>
        <ds:SignatureValue>
          SECOND SIGNATURE VALUE
        </ds:SignatureValue>
        <ds:KeyInfo>
          <wssec:LicenseLocation="#BinaryCredential"/>
        </ds:KeyInfo>
      </ds:Signature>
    </wssec:integrity>
  </S:Header>
  <S:Body>
```

-continued

```
78.        BODY
79.      </S:Body>
80.   </S:Envelope>
```

Line **1** defines the XML version that the SOAP envelope follows as well as the encoding format for the SOAP envelope as a whole.

Lines **2** through **80** define a SOAP envelope that includes two different credentials, two different signatures signed using the credentials, and references to the credentials for each of the signatures. Also, the encoding type and format type of each of the credentials is specified.

Lines **3** through **5** define global namespace abbreviations used throughout the SOAP envelope. It is standard practice to specify namespace abbreviation in this portion of the SOAP envelope. These namespace abbreviations correspond to a namespace that defines a standard for how particular elements to which the namespace applies are to be interpreted.

Lines **77** though **79** represent the body of the SOAP envelope and is an example of the body field **330** of FIG. **3**. Note that the actual body content is replaced with the capitalized term "BODY". Capitalized terms are used throughout the code example to replace actual content whose value is not specifically included in the code example and the value is not important to the principles of the present invention. For example, the term "BODY" in line **78** could be any content without affecting the principles of the present invention.

Lines **6** though **76** represent the header information for the SOAP envelope and is an example of the header field **310** of FIG. **3**.

Lines **7** through **9** express the path that the electronic message is to take. Intermediary computing systems such as intermediary computing system **411**B of FIG. **4**B may be specified in this section.

Lines **10** through **25** define a unique SOAP header called "credentials". This header may include several different credential types. The encoding format and type of the credential may also be specified in this header.

For instance, lines **12** through **18** contain a binary license (see line **17**) called "X509License" (see line **16**), which is identified as being an X.509 certificate (see line **14**), and which is identified as being encoded using base64binary encoding (see line **15**). Line **14** is an example of the credential type field **319**A of FIG. **3**. Line **15** is an example of the encoding format field **318**A of FIG. **3**. Line **17** is an example of the first credential field **315** of FIG. **3**.

Also, lines **19** through **24** contain a binary credential (see line **23**) called "BinaryCredential" (see line **22**), which is identified as being in a binary credential format (see line **20**), and which is identified as being encoded also using base64binary encoding (see line **21**). Line **20** is an example of the credential type field **319**B of FIG. **3**. Line **21** is an example of the encoding format field **318**B of FIG. **3**. Line **23** is an example of the second credential field **316** of FIG. **3**.

Lines **26** through **75** define an "integrity" header that contains two signatures, each having a reference location to find a corresponding credential that may be used to verify the integrity of the electronic message (i.e., that the electronic message was sent by the signer of the signature, and that the electronic message has not been altered in transit).

In particular, a first signature element is referenced from lines **27** through **50**, with the second signature element being referenced from lines **51** through **74**. Each signature element follows the schema defined by XML digital signature in accordance with the "http://www.w3.org/2000/09/xmldsig#" namespace. However, that KeyInfo child element within each XML digital signature includes a "LicenseLocation" element that references the location of a license (or other credential) that may be used to verify the integrity of the electronic message.

The first signature element includes a "SignedInfo" element from lines **28** through **43** which defines canonicalization methods, digest algorithms, and various transforms that apply to the signature. The first signature value is included at line **45** and is an example of the first signature field **312** of FIG. **3**. The license location specified at line **48** is an example of the reference to associated credential field **320**A of FIG. **3**.

The second signature element is similar to the first signature element except that the second signature value is at line **69** and represents an example of second signature field **313** of FIG. **3**, while the license location is specified at line **72** and represents an example of the reference to associated credential field **320**B of FIG. **3**.

Although the specific code example above includes the multiple credentials and signatures in the header portion of a SOAP envelope, the credential and/or signature information may also be included within the header portion of a Hyper-Text Transport Protocol (HTTP) message. Accordingly, the principles of the present invention allow for the communication of one or more different credentials in a single electronic message. In addition, the reference to an associated credential allows for the integrity of electronic messages to be verified.

In the above code example, there are two different credentials included in the electronic message, a binary license and a binary credential. These credential types may be abstractly structured in an inheritance tree. A hierarchically-structured credential semantics inheritance tree that includes these credential types is illustrated as tree **500** in FIG. **5**.

The tree **500** includes an abstract credential data type **501** at its base. The abstract credential is structured in accordance with a schema **501**A and has handling rules **501**B. The schema **501**A describes the basic structure of the abstract credential data type. The handling rules **501**B describe how to handle the abstract credential.

One of the first-tier branches of the tree **500** is an abstract license data type **511**, which includes an extended schema **511**A and extended handling rules **511**B. The schema and the handling rules from parent nodes in the tree **500** may be inherited by the child nodes. In other words, the schema **511**A of the abstract license may reflect the schema **501**A of the abstract credential with some specified extensions. Also, the handling rules **511**B may represent further handling rules in addition to the handling rules **501**B specified at the abstract credential data type.

Another of the first-tier branches of the tree **500** is a binary credential data type **512** that includes schema **512**A and handling rules **512**B. A second tier-branch of the tree includes binary license **521** having schema **521**A and handling rules **521**B. The tree **500** may be further expanded by defining a schema that extends on the schema of a parent node, and/or by defining further handling rules in addition to those provided for a parent node.

When determining how to structure a binary license for example, the source computing system would use the schema **521**A. If the schema **521**A represented incremental structural changes rather than a complete structural definition, the source computing system may also consult the schema of ancestral data types **511** and **501** to determine the final structural form of the binary license. When receiving a binary license, the recipient computing system may use the schema **521**A to determine how to parse the binary license, along with the handling rules **521**B to determine how to treat the binary license in terms of how to process the binary license and what authorities to grant in response to the binary license. The handling rules **521**B may represent incremental handling rules in which case the ancestral handling rules **511**B and **501**B may also be consulted to determine proper handling. The tree **500** may be stored at both the source computing system and the recipient computing system so as to ensure consistent treatment of credentials.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. In a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for a source computing system constructing an electronic message, the method comprising the following:

an act of designating at least one destination address in the electronic message, the destination address corresponding to one or more recipient computing devices;

an act of including a first security token in a header portion of the electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope in which the header portion is the header portion of the SOAP envelope, the first security token being at least derived from a first credential of a first credential type; and

an act of including a second security token in the header portion of the electronic message, the second security token being at least derived from a second credential of a second credential type.

2. The method in accordance with claim **1**, wherein the first security token is biometric data.

3. The method in accordance with claim **1**, further comprising the following:

an act of including an encryption manifest in the header portion to thereby designate portions of a body portion of the electronic message that are encrypted.

4. The method in accordance with claim **1**, further comprising the following:

an act of transmitting the electronic message with the first security token and the second security token in the header portion to the one or more recipient computing devices.

5. The method in accordance with claim **1**, wherein the first security token is the first credential.

6. The method in accordance with claim **1**, wherein the first security token is a first signature that was generated using the first credential.

7. The method in accordance with claim **6**, further comprising the following:

an act of including the first credential in the electronic message.

8. The method in accordance with claim **1**, wherein the second security token is the second credential.

9. The method in accordance with claim **1**, wherein the second security token is a second signature that was generated using the second credential.

10. The method in accordance with claim **9**, further comprising the following:

an act of including the second credential in the electronic message.

11. The method in accordance with claim **1**, wherein the at least one destination address corresponds to at least a first and a second recipient computing system, the first computing system using the first credential to identify the source computing system, and the second computing system using the second credential to identify the source computing system.

12. The method in accordance with claim **11**, further comprising the following:

an act of determining that the first recipient computing system uses the first credential to identify the source computing system; and

an act of determining that the second recipient computing system uses the second credential to identify the source computing system.

13. The method in accordance with claim **1**, wherein the at least one destination address corresponds to at least a first recipient computing system that uses both of the first credential and the second credential to identify the source computing system.

14. The method in accordance with claim **13**, further comprising the following:

an act of determining that the first recipient computing system uses both of the first credential and the second credential to identify the source computing system.

15. The method in accordance with claim **1**, wherein the at least one destination address corresponds to at least a first recipient computing system that uses the first credential and the second credential to identify the source computing system, the electronic message also traversing through an intermediary computing system that uses the second credential to identify the source computing system.

16. The method in accordance with claim **15**, further comprising the following:

an act of determining that the first recipient computing system uses the first credential to identify the source computing system; and

an act of determining that the intermediary computing system uses the second credential to identify the source computing system.

17. The method in accordance with claim **15**, further comprising:

an act of designating an intermediary address that corresponds to the intermediary computing device.

18. The method in accordance with claim **1**, further comprising

an act of encoding the first security token;

an act of including, in the header portion, an identification of an encoding format of the first security token; and

an act of including, in the header portion, an identification of a type of the security token.

19. The method in accordance with claim **18**, wherein the security token comprises a credential.

20. The method in accordance with claim 1, wherein the first security token is a signature generated by a user, the method further comprising:

an act of generating a reference indicating where a credential associated with the user may be found;

an act of including the reference in the header portion of the electronic message.

21. The method in accordance with claim 1, wherein the electronic message is a HyperText Transport Protocol (HTTP) message, and wherein the header portion is a header portion of the HTTP message.

22. A computer program product for use in a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, the computer program product for implementing a method for a source computing system constructing an electronic message, the computer program product comprising one or more computer-readable physical storage media have thereon the following:

computer-executable instructions for designating at least one destination address in the electronic message, the destination address corresponding to one or more recipient computing devices;

computer-executable instructions for including a first security token in a header portion of the electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope in which the header portion is the header portion of the SOAP envelope, the first security token being at least derived from a first credential of a first credential type; and

computer-executable instructions for including a second security token in the header portion of the electronic message, the second security token being at least derived from a second credential of a second credential type.

23. The computer program product in accordance with claim 22, wherein the one or more computer-readable media further have thereon the following:

computer-executable instructions for determining that a first recipient computing system uses the first credential to identify the source computing system; and

computer-executable instructions for determining that a second recipient computing system uses the second credential to identify the source computing system.

24. The computer program product in accordance with claim 22, wherein the one or more computer-readable media further have thereon the following:

computer-executable instructions for determining that a first recipient computing system uses both of the first credential and the second credential to identify the source computing system.

25. The computer program product in accordance with claim 22, wherein the one or more computer-readable media further have thereon the following:

computer-executable instructions for determining that a first recipient computing system uses the first credential to identify the source computing system; and

computer-executable instructions for determining that an intermediary computing system uses the second credential to identify the source computing system.

26. A computer program product for use in a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for identifying a source computing system of an electronic message, the computer program product comprising one or more physical computer-readable storage media having stored thereon the following:

computer-executable instructions for detecting the receipt of an electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the credential is included in a header portion of the SOAP envelope;

computer-executable instructions for reading a credential from the electronic message;

computer-executable instructions for determining how to handle the credential and the electronic message based on a position of the credential within a logical hierarchical tree of credentials;

computer-executable instructions for handling the credential and the electronic message as determined.

27. A computer program product in accordance with claim 26, wherein the computer-executable instructions for determining how to handle the credential and the electronic message comprise the following:

computer-executable instructions for consulting handling rules of at least one ancestral credential in the logical hierarchical tree;

computer-executable instructions for consulting extended handling rules specific to the credential included in the electronic message; and

computer-executable instruction for determining handling rules for the credential included in the electronic message by using the handling rules for the at least one ancestral credential as well as the extended handling rules specific to the credential included in the electronic message.

28. The computer program product in accordance with claim 26, wherein the credential includes biometric data.

29. The computer program product in accordance with claim 26, wherein the electronic message is a HyperText Transport Protocol (HTTP) message, and wherein the credential is included in a header portion of the HTTP message.

30. In a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for a source computing system constructing an electronic message, the method comprising the following:

an act of encoding a credential that identifies the source computing device;

an act of including the credential in a header portion of an electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the header portion is a header portion of the SOAP envelope; and

an act of including, in the header portion, information indicative of a type of the credential.

31. A method in accordance with claim 30, wherein the information indicative of a type of the credential comprises a human-readable expression of the type of the credential.

32. A method in accordance with claim 30, wherein the information indicative of a type of the credential comprises information that is not a human-readable expression of the type of the credential, but nonetheless is information from which the type of credential may be derived.

33. A method in accordance with claim 30, further comprising the following:

an act of including in the header portion, an identification of an encoding format of the credential.

34. A method in accordance with claim 30, wherein an identification of an encoding format of the credential is not included in the header portion thereby indicating that a default encoding format has been applied.

35. The method in accordance with claim 30, further comprising the following:

an act of including an encryption manifest in the header portion to thereby designate portions of a body portion of the electronic message that are encrypted.

36. The method in accordance with claim 30, wherein the credential includes biometric data.

37. The method in accordance with claim 30, wherein the electronic message is a HyperText Transport Protocol (HTTP) message, and wherein the header portion is a header portion of the HTTP message.

38. A method in accordance with claim 30, wherein the credential is a license.

39. A method in accordance with claim 38, wherein the credential is in a binary format, wherein the act of including, in the header portion, an identification of a type of the credential comprises an act of including, in the header portion, an indication that the credential has the binary format.

40. A method in accordance with claim 30, wherein the credential is in a binary format, wherein the act of including, in the header portion, an identification of a type of the credential comprises an act of including, in the header portion, an indication that the credential has the binary format.

41. A computer program product for use in a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, the computer program product for implementing a method for a source computing system constructing an electronic message, the computer program product comprising one or more physical computer-readable storage media having stored thereon the following:

a first software module that, when executed by one or more processors, is adapted to encode a credential that identifies the source computing device, wherein the credential is a license;

a second software module that, when executed by one or more processors, is adapted to include the credential in a header portion of the electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the header portion is a header portion of the SOAP envelope;

a third software module that, when executed by one or more processors, is adapted to include, in the header portion, an identification of an encoding format of the credential; and

a fourth software module that, when executed by one or more processors, is adapted to include, in the header portion, an identification of a type of the credential.

42. In a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for a source computing system constructing an electronic message, the method comprising the following:

an act of including an electronic signature in a header portion of an electronic message, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the header portion is a header portion of the SOAP envelope, the electronic signature generated by a user;

an act of generating a reference indicating where a credential associated with the electronic signature may be found;

an act of including the reference in the header portion of the electronic message.

43. The method in accordance with claim 42, further comprising the following:

an act of including an encryption manifest in the header portion to thereby designate portions of a body portion of the electronic message that are encrypted.

44. A method in accordance with claim 42, wherein the reference indicates that the associated credential may be found at a location that is internal to the electronic message.

45. A method in accordance with claim 42, wherein the reference indicates that the associated credential may be found at a location that is external to the electronic message.

46. The method in accordance with claim 42, wherein the credential includes biometric data.

47. The method in accordance with claim 42, wherein the electronic message is a HyperText Transport Protocol (HTTP) message, and wherein the header portion is a header portion of the HTTP message.

48. In a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for a recipient computing system to verify the identity of a sender of an electronic message, the method comprising the following:

an act of receiving the electronic message;

an act of reading an electronic signature from a header portion of the electronic message, the electronic signature generated by a user, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the header portion is a header portion of the SOAP envelope;

an act of reading a reference from the header portion, the reference indicating where a credential associated with the user may be found;

an act of using the reference to find the credential; and

an act of determining if the credential corresponds with the electronic signature.

49. A method in accordance with claim 48, wherein the reference indicates that the associated credential may be found at a location that is internal to the electronic message.

50. A method in accordance with claim 48, wherein the reference indicates that the associated credential may be found at a location that is external to the electronic message.

51. A computer program product for use in a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, the computer program product for implementing a method for a recipient computing system to verify the identity of a sender of an electronic message, the computer program product comprising one or more physical computer-readable storage media having thereon the following:

computer-executable instructions for detecting the receipt of the electronic message;

computer-executable instructions for reading an electronic signature from a header portion of the electronic message, the electronic signature generated by a user, wherein the electronic message is a Simple Object Access Protocol (SOAP) envelope, and wherein the header portion is a header portion of the SOAP envelope;

computer-executable instructions for reading a reference from the header portion, the reference indicating where a credential associated with the user may be found;

computer-executable instructions for using the reference to find the credential; and

computer-executable instructions for determining if the credential corresponds with the electronic signature.

52. In a network environment that includes a plurality of computing systems capable of communicating using electronic messaging, a method for a source computing system

constructing a Simple Object Access Protocol envelope, the method comprising the following:

an act of designating at least one destination address in the SOAP envelope, the destination address corresponding to one or more recipient computing devices; and

an act of including a first security token in a header portion of the SOAP envelope, the first security token being at least derived from a first credential of a first credential type.

53. The method in accordance with claim **52**, further comprising the following:

an act of including a second security token in the header portion of the SOAP envelope, the second security token being at least derived from a second credential of a second credential type.

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